SUPPORTING NUMBER SENSE WITH VIRTUAL MANIPULATIVES: PROFESSIONAL DEVELOPMENT FOCUSED ON PLAY

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ABSTRACT

During the transition from face-to-face to online teaching, we engaged pre- and in-service elementary school teachers in a virtual professional development session. Our main goal for the mathematics session was to encourage play with the use of virtual manipulatives (VMs) and provide activities that support the development of elementary school students' number sense. Early results indicate that providing opportunities to play with VMs, posting links, answering questions in the chat function, and focusing on a timely topic provided humanistic support during this pandemic.

Keywords: Professional development, virtual manipulatives, mathematics education, noticing, making meaning.

RATIONALE

The National Council of Teachers of Mathematics, NCTM (2014) states that, "An excellent mathematics program integrates the use of mathematical tools and technology as essential resources to help students learn and make sense of mathematical ideas…" (p. 78). To be effective, these tools do not have to be physical, but can be virtual. Virtual manipulatives (VMs) are "interactive, web-based visual representations of a dynamic object" (Moyer, Bolyard, & Spikell, 2002, p. 373). VMs provide access to all students as many are free, can be accessed at home, can be customized (change color and/or size), and can promote understanding of mathematical terms and symbols (CAST, 2018; Moyer et al., 2002). However, it is not enough to simply introduce VMs to students and expect them to be successful. Teachers need professional development (PD) opportunities to learn how to use these tools and to best support their students in making meaning (NCTM, 2014).

The spread of COVID-19 forced PD providers and K-12 schools to rethink how they provide access and continued learning opportunities for teachers and students alike. In this manuscript, we share a virtual PD session presented to engage elementary school pre- and in-service teachers in supporting students' number sense with VMs. Our goal was to encourage participants to consider how they might reimagine meaningful, virtual math experiences and provide access when students might not have physical manipulatives.

PROCESS

Given that teachers were on the cusp of transitioning to online instruction, it was important to provide a model for what could be possible online, and we wanted participants to play. Through this play, we wanted participants to engage in powerful mathematical thinking and consider how they could engage their students in this play. Therefore, we purposefully built in opportunities for participants to explore the VMs. These opportunities were more than just "go and explore;" we provided specific activities. This allowed participants to manipulate the VMs and the tools to complete the tasks. The three tasks included:

- **Task #1: "Build the number six in as many different ways as you can" using Rekenreks at https://bit.ly/2wqLnmf**
- **Task #2: Roll three dice, add the amounts. Do this two more times. How much under/over (25, 50, or 100) are you? Use dice from www.didax.com/apps/dice or https://toytheater.com/dice**
- **Task #3: Build the number 374 in at least three different ways using base ten blocks at https://bit.ly/2yuPwUa**
    - **After building 374, solve:**
        - **Costco had 374 rolls of toilet paper. They placed 10 rolls in a pack to sell. How many customers got a pack of toilet paper?**

These tasks allowed us to highlight pedagogical strengths of virtual manipulatives. Specifically, for Tasks 1 and 3, the URLs were created ahead of time through the Math Learning Center (www.mathlearningcenter.org/resources/apps). The facilitator wrote the task directions on the webpage, saved a link, and shared with participants. As the participants explored, they questioned whether the facilitator had access to their creations. This led to a conversation that although all 171 participants were able to access the link, they each could complete the task, create a new distinctive link for their work, and share it back with the facilitator. Participants suggested that they could create a Google Sheet with students' names so they could add their individual links of work samples and provide feedback.

EARLY RESULTS

After engaging with the VMs and answering questions, we provided a link to an online evaluation Google Form. A total of 60 participants completed the evaluation (35% response rate) and rated the overall quality of the session at 4.9 on a 5-point scale. Qualitative data suggests that participants appreciated the ability to play with the VMs; having access to the Google Slides and resources during the session; the collaborative team answering questions and pasting linking in the chat function; and a topic they could implement immediately. Key comments included:

- **"I loved playing with the VMs! My scholars will love this as well! I liked how you can share what you made with the link."**
- **"The links being provided in the chat box and the copy of the Slides presentation were great. Seeing how we could use the tools with prompted problem links was great too."**
- **"Relevant and timely topics of VM will support transition to online teaching. Excellent concrete examples that can be immediately implemented."**

Participants provided additional suggestions for future sessions such as the use of breakout rooms. They also requested that links to the VMs be sent earlier to explore on their own. Lastly, some participants requested a longer session to explore the different online platforms each district was using and how to integrate the VMs.

OUTCOMES

Our anticipated outcomes were for pre- and in-service teachers to engage with the VMs and consider how to engage students in meaningful mathematics. Based on the evaluation, participants were excited to share these resources with students and colleagues.

The free online websites for VMs include:

- **www.mathlearningcenter.org/resources/apps**
- **https://toytheater.com/category/teacher-tools/virtual-manipulatives**
- **www.didax.com/math/virtual-manipulatives.html**

REPLICATION

A few suggestions for those outside of mathematics education include the following. First, limit the length of the session and provide opportunities to be actively engaged. By providing time to explore, participants can view each tool's potential and seek ideas to adjust for their context. Second, identify topics that are "in demand" to support teachers now. We sought input from teachers and scoured social media to pinpoint needs to guide decisions on topics of interest. Lastly, focus on effective teaching. VMs on their own will not ensure learning. However, providing meaningful experiences for students will help maintain skills that future teachers can build on later.

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